EP-2081

Impact of baseline shifts on 4D cone-beam CT images using a 4D phantom driven by lung tumor motions

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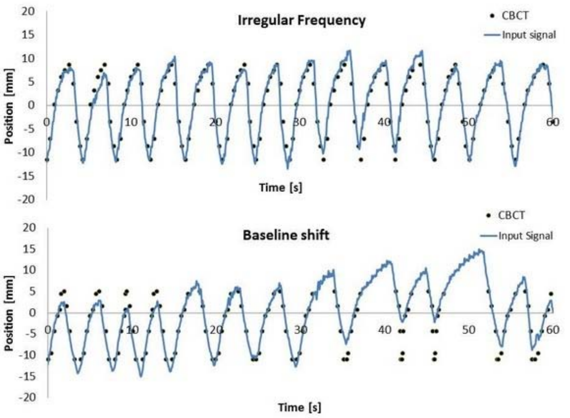
Purpose or Objective: We have evaluated clinical impacts of the breathing instability for lung cancer patients on4Dcone-beam CT images usingan XVI version 5.0 unit (Elekta, Crawley, UK)using a moving phantom driven by actual patient's tumor motions.

Material and Methods: The XVI unit calculated 10-phase binned 3D volume data based on the tumor positions oneach of the projection images and the resulting 10-phase binned breathing curve was stored in the unit. The breathing curve consisting of the 10 sets of the 3D coordinates were compared to the 4D input data which had been fed into the phantom controller.In order to simulate the tumor baseline shifts during relatively long treatment. a 1D phantom, QUASAR™ Respiratory Motion Phantom(modusQA, city or state, USA), was employed, wherein measured patient tumor motions had beenfed into the phantom controller beforehand.

Results: When the breathing motions were stable without significant tumor baseline shifts, the tumor motion shown on the4D CBCT imagesagreed with the true patient tumor motions. However, when the baseline shifts were significant, the reconstructed images showed unclear and blurredtumors. In particular, the tumor position deviations were significant during the period of large baseline shifts. Moreover, during that period, the tumor was located outside theinternal target volume (ITV) region, thereby causing possible treatment failure.To avoid this failure, either breathhold or constrainedbreathing may be more appropriate than free breathing.Furthermore, a quick beam delivery such as volumetric modulated arc therapy (VMAT) or flattening filter free beams may minimize the impact of the baseline shifts on the CBCT images.



Conclusion: We have confirmed that the XVI version 5.0 unit accurately calculated 10-phase binned 1D phantom positions for stable breathing. However if baseline shift occurs significantly during the projection data acquisition, the reconstructed tumor positions may be incorrect. It is recommended that a sufficient period of preparation time may be required for a patient before treatment. volume (ITV) region, thereby causing possible treatment failure.To avoid this failure, either breathhold or constrainedbreathing may be more appropriate than free breathing.Furthermore, a quick beam delivery such as volumetric modulated arc therapy (VMAT) or flattening filter free beams may minimize the impact of the baseline shifts on the CBCT images.

EP-2082

Static beam tomotherapy (TD) as an optimisation method in whole breast radiation therapy (WBRT)

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Purpose or Objective: To evaluate static beam tomotherapy (TD) as a method of dose optimisation for the delivery of whole breast radiation therapy (WBRT).

Material and Methods: Treatment plans of 27 women previously optimised with IMRT on RayStation v4.5 (Raysearch, Stockholm, Sweden) were replanned using TomoDirect (Accuray, Sunnyvale, California, United States). TD parameters included a field width of 2.5cm, a pitch of 0.251 and a modulation factor of 2.000. A simple two field (medial and lateral) beam arrangement was utilised, with no OARs included in the optimisation. A simple ring volume (+0.2cm-+2.0cm) was used to control integral dose. Planning optimisation time was recorded. Prescriptions were normalised to 50Gy in 25 fractions prior to comparison.

Results: Both groups fell within ICRU62 target homogeneity objectives (TD D99 = 48.0Gy vs IMRT = 48.1Gy, p = 0.26; TD D1 = 53.5Gy vs IMRT = 53.0Gy, p=0.02; HI TD = 0.110 vs IMRT = 0.099, p=0.03), with TD plans showing higher median doses (TD median = 51.1Gy vs IMRT = 50.9Gy, p = 0.03). No significant difference was found in prescription dose coverage (TD VTD = 85.5% vs IMRT = 82.0%, p = 0.09). TD plans produced a statistically significant reduction in V5 ipsilateral lung doses (TD V5 = 23.2% vs IMRT = 27.2%, p = 0.04), whilst other queried OAR metrics remained statistically comparable (TD ipsilateral lung V20 = 13.2% vs IMRT = 14.6%, p = 0.30; TD heart V5 = 2.7% vs IMRT = 2.8%, p = 0.47; TD heart V10 = 1.7% vs IMRT = 1.8%, p = 0.44). TD user optimisation time decreased (TD = 9.8m vs IMRT 27.6m, p<0.01), saving an average planning time of 17.8 minutes per patient.

Conclusion: TD represents a viable and superior alternative WBRT technique, both in terms of plan quality metrics and user efficiency.

EP-2083

Utilising flattening filter free (FFF) beams to reduce treatment delivery times for breast patients

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Purpose or Objective: This is a feasibility study to compare treatment delivery times of four different techniques for DIBH left sided whole breast RT to minimise the treatment delivery time without compromising the target coverage. In addition to technique comparison, the possible use of flattening filter free beams will also be assessed.

Material and Methods: Ten left sided DIBH patients were selected. Four separate plans were created for each patient. The treatment techniques used were: conventional tangents comprising of open wedged fields (two to four beams), forward planned segmentation (two beams), hybrid inverse planned intensity modulated radiation therapy (IMRT) (four beams) and volumetric modulated arc therapy (VMAT) (two partial arcs). All plans were optimised to the departmental breast protocols. Plans were then delivered on a Varian21iX linear accelerator (Varian Medical Systems, CA, USA) using Millennium 120 leaf MLC. The maximum dose rate was 600 monitor units per minute. Each plan was delivered three times with the beam on time recorded for each beam. Patients were replanned for forward planned segmentation and inverse planned IMRT using flattening filter free (FFF) beams. Each plan was delivered three times with the beam on time recorded for each beam. The maximum dose rate was 1400 monitor units per minute.

Results: When comparing dosimetric endpoints four treatment techniques without the inclusion of FFF, IMRT performed statistically better 2cc PTV maximum, 2cc body maximum and homogeneity index for the PTV compared to all other techniques. In general Organs at Risk (OAR) constraints were comparable between the conventional tangents, Field in field and hybrid IMRT techniques. VMAT performed statistically worse in several endpoints including both the point maximum and mean dose for the contralateral breast, Volume receiving 10Gy (V10) and 5Gy (V5) for the heart, ipsilateral and contralateral lung V5 and mean dose as well as the mean dose for combined lung compared to all other techniques planned.
There was no statistical difference for the V20 for the ipsilateral lung and combined lung for all techniques. When looking at the beam on time Hybrid IMRT(10.21s) had the quickest and VMAT(48.76s) the longest.
When comparing dosimetric endpoints four treatment techniques with the inclusion of FFF hybrid IMRT and FFF Hybrid IMRT performed statistically better for PTV2cc max, PTV homogeneity index, total body max and 2cc max. For all other OAR parameters tested in the investigated modulated techniques, treatment planning with FFF beams resulted in plans of equal quality compared with flattened beams. No significant differences were found. When looking at the beam on time FFF Hybrid IMRT(7.45s) had the quickest compared to current tangential delivery times (20.59s).

Conclusion: The inclusion of FFF beams and modulated techniques can significantly reduce treatment delivery times for left sided breast patients who are receiving (DIBH)

EP-2084

Risk assessment of secondary cancer after craniospinal radiotherapy in childhood medulloblastoma

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Purpose or Objective: Primary central nervous system tumors represent the second most common neoplasms in childhood.The late effects, after radiation treatment (RT), develop gradually over several years, including neurocognitive deficiencies, cardiac toxicity, endocrinological problems, and secondary malignancies (SMNs).The incidence of SMNs is around 10–20%, 30 years after treatment. Predicting SMN risk, from the newer RT, techniques is difficult due to absence of epidemiological data, but mathematical models can be used. The aim of this paper is to determine possible dose-response relationships between radiotherapy dose and specific organs SMNs comparing conventional technique (3D-CRT) with IMRT delivered with Helical Tomotherapy (HT).

Material and Methods: In this work a dose-response relationship for malignant tumors is derived based on: the epidemiological data on cancer induction after Hodgkin's disease; from the data about cancer induction of the A-bomb survivor data("the linear-no-threshold model"). The data from two young patients, affected by medulloblastoma "standard risk"(female age 7y, male age 8y) treated at the National Cancer Institute in Aviano (Italy), were retrospectively analyzed using the Schneider's dose-response model for solid cancers induction (Theoretical Biology and Medical Modelling 2011). We calculated the impact of the different techniques on SMN induction risk, using organ equivalent dose (OED) calculated for a group of different dose-response models including a full model and linear model. The excess absolute risk (EAR/10000 pts-year) was considered for different organs at risk(OAR).

Results: The results demonstrated that the the linear model fits best colon, cervix and skin. Instead the full model fits all other organs, indicating that the repopulation/repair ability of tissue is neither 0 nor 100% but somewhere in between. We noted that soft tissue sarcoma fitted well by all the models and in the low dose range beyond 1 Gy the risk is negligible, but for increasing dose, sarcoma risk increases rapidly and reaches a plateau at around 25-30 Gy. From the analysis of the EAR breasts, we observed values of 11.5 in 3DCRT plan and of 43.9 in HT plan, respectively. This difference in EAR may be results due to missing of delineation of breast as OAR in pre-planning. The table n. 1 showed the EARk for each OAR in specific dose ranges, calculated for both treatment plans.

SITE	EAR 0-5 Gy		EAR 5-20 Gy		EAR 20-26 Gy	
	3DCRT	TOMO	3DCRT	TOMO	3DCRT	TOMO
Soft tissue	0,0012	0,006	0,97	0,5	2,3	2,2
Thyroid	5,7	9,02	11,5	11,2	0	0
Bladder	2,9	1,7	0	0	0	0
Lung	3,4	9,5	29,4	21,5	38,3	38,4
Bone	0,00083	0,0035	0,47	0,26	0,78	0,79
Small Bowel	6,7	4,3	1,54	2,34	1,3	0
Skin *	0,5	1,9	15,6	10,4	24,2	25,1
Skin **	0,4	1,9	15,6	10,7	24,2	24,4

Conclusion: In this work OED for various OAR was calculated using different models and compared in two plans, in combination with epidemiological obtained absolute risk data. The models have taken into account also the age, important parameters in pediatric population. We think that, in the field of radiation therapy, estimated excess risk it may be interesting to know the advantage of different treatment techniques , in reference to the same organ and the same patient (sex ,age,exposure and expected years of life).

EP-2085

Breast irradiation: Is the Isocenter fix ? Results of a Quality Control study.

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Purpose or Objective: The accuracy and reproducibility of tangential fields in breast cancer irradiation is crucial in the sense of tumor control. Small deviation in patient positioning can lead to geometrical miss and low doses in parts of the target as well as exposing OAR (i.e heart and lung) to high doses. Although portal imaging verification can reduce such errors, it is time consuming and could affect machine occupancy. Once the setup is performed in the first treatment it is possible to achieve reproducibility in the AP direction through SSD or couch vertical reading .The aim of this work was to test which of the two should be used in order to achieve better reproducibility through the treatment and whether the Isocenter is truly fixed during the treatment course.

Material and Methods: The study included 30 patients, treated between November 2014 and May 2015 at the ages 34 to 85, with an average age of 60. Total 634 portal images